Functional Health Literacy and the Risk of Hospital Admission Among Medicare Managed Care Enrollees

David W. Baker, MD, MPH, Julie A. Gazmararian, PhD, MPH, Mark V. Williams, MD, Tracy Scott, PhD, Ruth M. Parker, MD, Diane Green, PhD, Junling Ren, MEd, and Jennifer Peel, MPH

Objectives. This study analyzed whether inadequate functional health literacy is an independent risk factor for hospital admission.

Methods. We studied a prospective cohort of 3260 Medicare managed care enrollees.

Results. Of the participants, 29.5% were hospitalized. The crude relative risk (RR) of hospitalization was higher for individuals with inadequate literacy (n=800; RR=1.43; 95% confidence interval [CI]=1.24, 1.65) and marginal literacy (n=366; RR=1.33; 95% CI=1.09, 1.61) than for those with adequate literacy (n=2094). In multivariate analysis, the adjusted relative risk of hospital admission was 1.29 (95% CI=1.07, 1.55) for individuals with inadequate literacy and 1.21 (95% CI=0.97, 1.50) for those with marginal literacy.

Conclusions. Inadequate literacy was an independent risk factor for hospital admission among elderly managed care enrollees. (*Am J Public Health.* 2002;92:1278–1283)

The National Adult Literacy Survey reported in 1993 that more than 40 million Americans were functionally illiterate, meaning that they could not perform the basic reading tasks necessary to function fully in society.[1] Although the National Adult Literacy Survey did not include health-related items, these findings suggest that a large proportion of Americans are unable to read and comprehend essential information they are likely to encounter when they interact with the health care system. A study conducted at 2 public hospitals found that one third of the English-speaking patients were classified as having inadequate functional health literacy, indicating that they were unable to read and comprehend the most basic health-related materials.[2] Such individuals are likely to struggle to read and comprehend prescription bottles, appointment slips, self-care instructions, and health education brochures. Similarly, individuals with inadequate literacy who have chronic diseases are less likely to know the basic elements of how to care for their medical problems, even if they have gone to special classes to learn how to manage their conditions.[3,4]

Inadequate literacy is especially prevalent among the elderly, the population with the largest burden of chronic disease and the greatest health-related reading demands. In the National Adult Literacy Survey, 44% of the adults aged 65 and older were classified as functionally illiterate.[1] The lower reading ability among older adults is most likely the result of age-related declines in information processing, and it is not explained by their having less education, a higher prevalence of chronic diseases, worse physical or mental health, or dementia.[5] Many elderly persons have difficulty understanding basic health information. Among Medicare managed care enrollees aged 65 and older in 4 US cities, 34% had inadequate or marginal functional health literacy.[6]

The discordance between what we expect of patients and what is required for them to function optimally in the health care setting may have important cost implications. Although Weiss et al.[7] found no relation between literacy and medical care costs for a random sample of Medicaid recipients in Arizona, Kuh and Stirling[8] found that the risk of hospitalization for diseases of the female genital system was more than twice as high for the least educated compared with the most educated women. Similarly, we reported previously that among patients at a public hospital in Atlanta, Ga, those with inadequate literacy had a 52% higher risk of hospital admission compared with those with adequate literacy, even after adjustment for age, socioeconomic markers, and self-reported health.[9] The patients in that study were uniformly poor, and most had limited access to ambulatory care providers. Thus, the generalizability of the study findings is not known.

It is important to gain a more accurate understanding of the relation between literacy and health care costs. If inadequate literacy leads to worse health outcomes and higher health care costs, then an incentive exists for health care providers and payers to develop education programs to reach all patients, regardless of reading ability. To explore the relation between functional health literacy (the ability to read and understand health-related materials) and the risk of hospital admission, we conducted a prospective cohort study of 3260 new Medicare managed care enrollees in 4 US cities whose literacy was assessed with the short version of the Test of Functional Health Literacy in Adults.[10,11]

METHODS

Patient enrollment and data collection for this study have been described in detail previously.[6] New Medicare enrollees in health plans of a national managed care organization in 4 US cities (Cleveland, Ohio; Houston, Tex; Tampa, Fla; and Ft Lauderdale–Miami, Fla) were eligible to participate. Three months after enrollment, a letter of introduction describing the study and how confidential information collected during this study would be handled was sent to each member who was at least 65 years of age. One week later, interviewers called each enrollee to determine eligibility. Individuals who indicated that they were not comfortable speaking either English or Spanish; were blind or had a severe vision problem that could not be corrected with glasses; or did not know what year or month it was, what state they lived in, what year they were born, or their address were ineligible.

Baseline Interview and Literacy Testing

Eligible individuals who agreed to participate in the study completed a 1-hour face-to-

face interview in their home. The survey consisted of questions to determine demographics, years of school completed, income, current and past smoking, current alcohol use, problem drinking as measured by the CAGE questionnaire,[12] chronic conditions (hypertension, diabetes, heart disease, chronic obstructive pulmonary disease or asthma, arthritis, or cancer), depression (measured by the Geriatric Depression Scale[13]), self-rated physical and mental health (measured by the SF-12[14]), and social support.[15] Individuals were classified as non-Hispanic White, non-Hispanic Black, native English-speaking Hispanic, native Spanish-speaking Hispanic, and other. Annual income was measured by having respondents select from 1 of 8 income categories.

The Mini–Mental State Examination was administered in a standardized format with a maximum score of 30.[16] The last section of the survey assessed the enrollee's health literacy with the short version of the Test of Functional Health Literacy in Adults.[10,11] The short version of the Test of Functional Health Literacy in Adults uses actual materials that patients might encounter in the health care setting to test their reading ability. The reading comprehension section is a 36-item test that uses the modified Cloze procedure; that is, every fifth to seventh word in a passage is omitted, and 4 multiple-choice options are provided.[17] Participants read the passage and select the multiple-choice option that best completes the blank, given the context of the surrounding phrases. The reading comprehension section measures the ability to read and understand prose passages selected from instructions for preparation for an upper gastrointestinal tract radiograph series and the patient "Rights and Responsibilities" section of a Medicaid application. Readability levels of these passages on the Gunning–Fox index (Rosenbaum, Graham–Field Surgical Co, Inc, New Hyde Park, NY) are grades 4.3 and 10.4, respectively.

The numeracy section of the short version of the Test of Functional Health Literacy in Adults is a 4-item measure that uses actual hospital forms and labeled prescription vials. It tests a patient's ability to comprehend directions on 2 prescription bottles, whether the blood glucose level is within a normal range, and appointment instructions written on an actual appointment slip. Participants are given a prop to read and then asked a question; they are allowed to look back at the prop for as long as they would like to answer the question. The numeracy score is multiplied by 7 (×4 items) to create a score ranging from 0 to 28, and each item in the reading comprehension section is multiplied by 2 (×36 items) to create a score ranging from 0 to 72. The sum of the 2 sections yields the short version of the Test of Functional Health Literacy in Adults score, which ranges from 0 to 100. Scores from 0 to 55 indicate inadequate literacy; these individuals often misread the simplest materials, including prescription bottles and appointment slips. Scores between 56 and 66 indicate marginal literacy, and scores from 67 to 100 indicate adequate literacy; the adequate literacy group will successfully complete most of the reading tasks required to function in the health care setting, although they still may misread the most difficult numerical information.

The short version of the Test of Functional Health Literacy in Adults takes 12 minutes or less to administer, and it has been shown to have good internal consistency, reliability (Cronbach $\alpha=0.98$ for all items combined), and validity compared with the long version of the Test of Functional Health Literacy in Adults (Spearman rank correlation=0.91) and the Rapid Estimate of Adult Literacy in Medicine[18] (Spearman correlation coefficient=0.80).

Before completing the survey section containing the short version of the Test of Functional Health Literacy in Adults, each enrollee's vision was examined with the Rosenbaum Handheld Vision Chart. Those whose corrected vision was 20/50 or better were administered the standard short version of the Test of Functional Health Literacy in Adults (12-point font). Those whose vision was 20/70 to 20/100 were administered the large-print version (14-point font) of the short version of the Test of Functional Health Literacy in Adults. Participants whose corrected vision was worse than 20/100 could not have their reading skills accurately assessed, so they were excluded from analysis (n=71). Respondents who indicated that they could not read at all (n=10) were assigned a score of 0.

Hospital Admissions

Patients were interviewed between April and December 1997. Hospital admissions were determined for all individuals from the time of enrollment in the Medicare managed care plan until April 30, 1999, based on claims from the managed care organization. For each admission, the time from the date of plan enrollment to admission date was determined. Primary-diagnosis *International Classification of Diseases, 9th Revision (ICD-9)* codes also were obtained for all admissions.

Statistical Analysis

All analyses were conducted with SAS, Version 6.12 (SAS Institute Inc, Cary, NC). Because the duration of follow-up ranged from 18 to 24 months, we used time to first hospital admission as our main dependent variable. Individuals were censored if they died (n=25) or disenrolled (n=58) without being hospitalized. In addition, we analyzed time to first admission or death as a combined outcome, and the results were almost identical. Therefore, only the results of analyses using time to first hospital admission are presented. Participants with inadequate functional health literacy were more likely to disenroll without being hospitalized (adjusted relative risk (RR)=1.91, 95% confidence interval [CI]=1.02, 3.58).

The relation between functional health literacy and time to first hospital admission was first examined with Kaplan–Meier curves, and unadjusted hazard ratios were determined from Cox proportional hazards models. We then adjusted for other covariates in a series of models to evaluate the additive effect of adjusting for demographics, socioeconomic status, health behaviors, chronic diseases, and self-reported physical and mental health. These variables were selected a priori for inclusion in models. The number of chronic conditions was linearly related to the risk of admission and showed a stronger relation to admissions than did the Charlson Comorbidity Index[19]; thus, the number of chronic conditions was entered as a continuous variable. A total of 16% of the participants refused to give income information. To decrease the effect of nonresponse bias, income was imputed based on age, sex, race/ethnicity, literacy, and past occupation. The relation between literacy and the risk of hospital admission was somewhat greater when only individuals with complete income data were analyzed. Finally, interaction terms between literacy and all other covariates in the

model were examined to determine whether the relation between literacy and the risk of hospital admission differed for patient subgroups. In all analyses, a 2-sided *P* value of .05 was used to determine statistical significance.

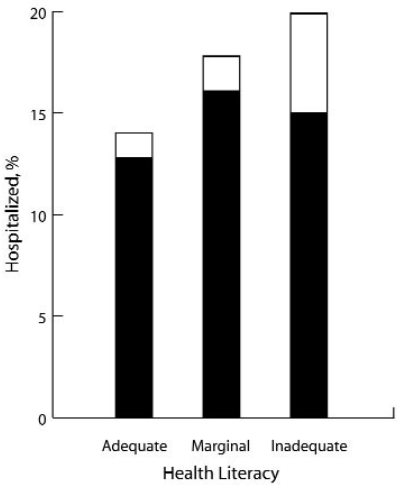
RESULTS

A total of 7471 enrollees were contacted by telephone 3 months after they enrolled in the managed care plan. Of these, 3390 refused to participate, 737 did not meet eligibility criteria, and 3344 completed the in-home interview. A total of 84 individuals were excluded because they did not complete the short version of the Test of Functional Health Literacy in Adults, leaving 3260 participants available for analysis. Nonresponders were more likely to be aged 85 or older (7.5% vs 5.4%) and more likely to be male (45.2% vs 42.6%). Nonresponders also lived in zip code areas with a higher median per capita income (27.8% lived in an area with a median per capita income of greater than $17 842 per year, compared with 10.7% of responders) and higher educational attainment.

TABLE 1—Participant Characteristics, by Literacy Level, According to the Short Version of the Test of Functional Health Literacy in Adults

	Adequate (n = 2094)	Marginal (n = 366)	Inadequate (n = 800)
Age, mean y ± SD*	71.6 ± 5.6	74.1 ± 6.3	75.6 ± 7.2
Female, %	57.9	53.8	57.8
Race/ethnicity, %*			
White	84.0	68.0	25.2
African American	6.6	12.6	58.6
Hispanic, English-speaking	1.6	2.5	2.3
Hispanic, Spanish-speaking	6.6	16.4	13.0
Other	1.2	0.6	1.0
Annual income, $, %*			
< 15 000	36.6	56.0	67.1
15 000–24 999	34.3	29.2	24.8
25 000–49 999	22.7	12.6	7.0
≥ 50 000	6.4	2.2	1.1
Years of school completed, %*			
0–8	7.1	24.2	40.9
9–11	14.9	25.6	24.3
12 or general equivalency diploma	38.3	30.2	22.8
> 12	39.7	20.0	12.0
Smoking, %*			
Never	38.3	42.6	45.1
Former	49.2	44.8	42.9
Current	12.6	12.6	12.0
Current alcohol use, %[a]*			
None	58.5	64.7	75.1
Light to moderate	37.5	33.3	23.3
Heavy	4.0	1.9	1.6
≥ 2 positive responses on CAGE, %	7.9	7.9	13.7
No. of chronic conditions, mean (SD)[b]	1.9 (1.4)	2.1 (1.5)	2.2 (1.5)
Physical Health Summary Scale, mean (SD)[c]	46.4 (10.7)	43.7 (11.7)	41.9 (11.9)
Mental Health Summary Scale, mean (SD)[c]	55.6 (8.0)	55.1 (9.2)	52.2 (10.7)

[a]Current alcohol use was classified as light to moderate for men who said they had 1–14 drinks of alcohol over the past month and women who said they had 1–7 drinks of alcohol over the past month. Those who drank more than this were classified as heavy drinkers.
[b]Chronic conditions included hypertension, diabetes, heart disease, chronic obstructive pulmonary disease or asthma, arthritis, and cancer.
[c]Physical and mental health were measured with the SF-12 physical and mental health summary scales.
*$P < .01$ for comparison across all 3 groups.

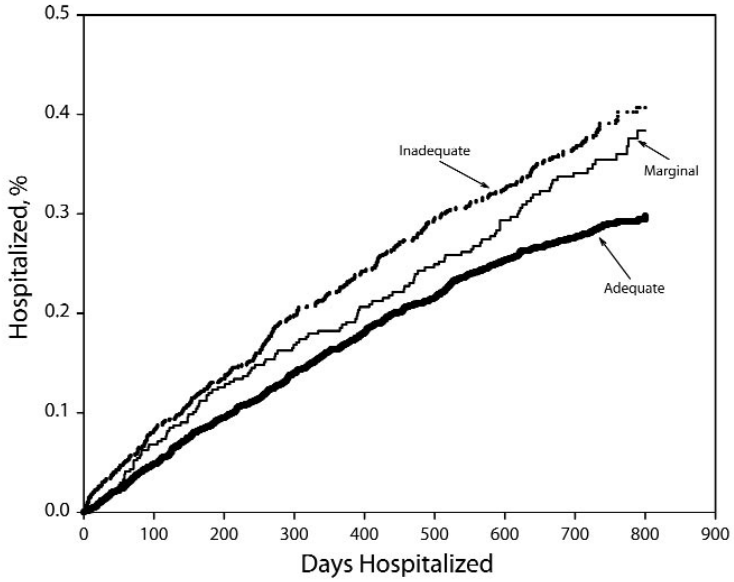


Note. $P < .001$ for difference in ≥ 1 admission across all 3 groups.

FIGURE 1—Percentage of study participants hospitalized once (black) or 2 or more times (white), by functional health literacy.

Among participants, individuals with inadequate literacy were older, were more likely to be non-White, and had lower income and education compared with individuals with adequate literacy (Table 1). They were less likely to have ever smoked cigarettes and less likely to have used alcohol during the past month, and their health status was worse than those with adequate literacy (Table 1).

A total of 963 (29.5%) participants were hospitalized 1 or more times during follow-up. Individuals with inadequate and marginal functional health literacy were more likely to be hospitalized than were those with adequate literacy (34.9%, 33.9%, and 26.7%, respectively; $P < .001$ across all 3 groups by χ^2 test; Figure 1). Those with inadequate and marginal functional health literacy also were more likely to be hospitalized 2 or more times than were those with adequate literacy (19.9%, 17.8%, and 14.0%, respectively; $P < .001$; Figure 1). However, the rate of readmissions among those hospitalized 1 time was



Note. $P < .001$ for differences between inadequate vs adequate and marginal vs adequate literacy.

FIGURE 2—Cumulative rate of hospitalization from time of enrollment for study participants, by functional health literacy.

similar across the 3 groups (57.0%, 52.4%, and 52.3%, respectively; $P=.42$).

The time to first hospital admission is shown in Figure 2. The unadjusted relative risk of hospitalization was 1.44 (95% CI= 1.25, 1.66) for individuals with inadequate functional health literacy compared with those with adequate literacy. Individuals with marginal literacy also were at increased risk (unadjusted RR=1.29; 95% CI=1.07, 1.57).

The most common discharge diagnoses were congestive heart failure (n=69), acute myocardial infarction and unstable angina (n=61), stroke (n=51), cardiac arrhythmias (n=46), pneumonia (n=36), exacerbations of chronic obstructive pulmonary disease or asthma (n= 35), and gastrointestinal hemorrhage (n=27). The numbers of admissions in any of these categories were too small to determine whether the condition-specific admission rates differed according to functional health literacy, but there were no marked differences in the reasons for admission across groups.

After adjustment for differences in age, sex, race/ethnicity, language, years of school completed, and income, the adjusted relative risk of hospitalization was 1.27 (95% CI=1.07, 1.52) for individuals with inadequate functional health literacy and 1.22 (95% CI=1.00, 1.50) for those with marginal literacy, compared with those with adequate literacy (Table 2). Subsequent models that adjusted for health behaviors, chronic disease prevalence, and self-reported overall health showed almost identical results for people with inadequate literacy (adjusted RR in final model=1.29; 95% CI= 1.07, 1.55). However, the relative risk for those with marginal literacy declined slightly, to 1.21 (95% CI=0.97, 1.50) in the final model (Table 2), which was no longer statistically significant ($P=.09$). The other significant predictors of hospital admission in the final model were older age, female gender, residence in south Florida, number of chronic diseases, and worse self-reported physical health. Spanish-speaking Hispanic individuals had a lower risk of admission regardless of literacy (adjusted RR=0.70; 95% CI=0.52, 0.94). Years of school completed was not significantly associated with the risk of admission.

In addition to the a priori covariates, we conducted an additional model in which the Mini–Mental State Examination score was entered. The Mini–Mental State Examination

TABLE 2—Crude and Adjusted Relative Risks (95% Confidence Intervals [CIs]) of Hospital Admission for Individuals With Inadequate and Marginal Functional Health Literacy Compared With Those With Adequate Literacy in Cox Proportional Hazards Models

Variables in Model[a]	Inadequate		Marginal	
	Relative Risk (95% CI)	P[b]	Relative Risk (95% CI)	P[b]
Functional health literacy	1.43 (1.24, 1.65)	<.001	1.33 (1.09, 1.61)	<.001
Functional health literacy, age, sex, race/ethnicity, education, and income	1.27 (1.07, 1.52)	.007	1.22 (1.00, 1.50)	.05
Functional health literacy, age, sex, race/ethnicity, education, income, smoking, and alcohol use	1.27 (1.07, 1.51)	.008	1.23 (1.01, 1.51)	.04
Functional health literacy, age, sex, race/ethnicity, education, income, smoking, alcohol use, chronic diseases	1.25 (1.05, 1.49)	.01	1.18 (0.96, 1.44)	.11
Functional health literacy, age, sex, race/ethnicity, education, income, smoking, alcohol use, chronic diseases, and self-reported physical and mental health[c]	1.29 (1.07, 1.55)	.007	1.21 (0.97, 1.50)	.09

Note. $P < .001$ for difference in ≥1 admission across all 3 groups.
[a]All models are also adjusted for study site.
[b]P value compared with the group with adequate literacy in Cox proportional hazards model.
[c]This model includes an interaction term between literacy and self-reported physical health. The relative risks shown are for an individual whose self-reported physical health was at the mean for the entire study population. The relative risk was higher for those whose health was above the mean and lower for those whose health was below the mean.

score was not significant, indicating that the relation between literacy and the risk of hospital admission was not a result of differences in cognitive function. Similarly, social support was not associated with the risk of admission.

The relation between literacy and hospitalization varied substantially according to baseline self-reported physical health, with the effect of literacy being greater for those in better health ($P<.001$ for the interaction term between inadequate literacy and physical health and $P=.05$ for the interaction term between marginal literacy and physical health). Thus, the relative risks described above are for individuals whose self-reported physical health was at the mean for the entire study population. Based on models with the interaction terms, the relative risk of hospital admission for individuals whose self-reported physical health was 1 SD above the mean was 1.60 (95% CI= 1.24, 2.07) for those with inadequate literacy and 1.42 (95% CI=1.02, 1.96) for those with marginal literacy, compared with those with adequate literacy. Conversely, for individuals whose self-reported physical health was 1 SD below the mean, the relative risk of hospital admission was 0.99 (95% CI=0.83, 1.18) for those with inadequate literacy and 0.99 (95% CI=0.79, 1.23) for those with marginal literacy, compared with those with adequate literacy. No other interactions were significant.

DISCUSSION

This study provides additional evidence that inadequate health literacy is an independent risk factor for hospital admission. Baker and colleagues[9] reported that individuals with inadequate functional health literacy had a 52% higher risk of hospital admission. However, that study was confined to a single public hospital; little information was available on patients' health behaviors, chronic diseases, and physical functioning; and hospitalizations outside of the study hospital were not captured. In contrast, the current study enrolled community-dwelling elderly individuals in 4 US cities who were cared for by a diverse set of physicians. Detailed information was collected on an extensive set of covariates proven or postulated to affect hospitalization. Administrative claims data were used to determine hospitalizations, which should result in high ascertainment and little potential for systematic bias according to literacy. Thus, this study provides stronger evidence that inadequate functional health literacy is independently associated with the risk of hospital admission.

The relative risk of admission for patients with inadequate literacy was approximately half that reported previously for public hospital patients. The earlier study could have overestimated the association between inadequate literacy and the risk of hospital admission because of incomplete adjustment for confounders. However, the effect of inadequate literacy on hospitalizations may vary, depending on characteristics of the health care system and the patient population. Specifically, the effect of inadequate literacy may be greater for individuals who do not have a regular provider or who face significant administrative barriers to obtaining care, as was the case in the earlier study conducted at a public hospital.

The relation between functional health literacy and the risk of hospitalization varied substantially according to self-reported physical health. Inadequate literacy did not appear to be a risk factor for individuals whose physical health was below average. This finding was not expected and could have been due to chance. However, the finding also may have resulted because people in poor health are more likely to receive assistance in their medical care from family, friends, or home health care workers. For example, in a national sample of the United States, 27.7% of the elderly persons who rated their health as fair or poor received at least 1 formal home health care visit in 1996, compared with 9.3% of those in good to excellent health.[20] Family, friends, and home health care workers may act as "surrogate readers" for individuals with inadequate literacy and thus may mitigate the negative effects of inadequate literacy on patients' understanding of their medications and self-care instructions.[2,21] In contrast, individuals who are in average or above-average health may rely more on their own reading abilities to decipher medical instructions, and this may put them at risk for preventable hospitalizations.

We also examined whether the lack of relation between literacy and hospital admissions among individuals in poor health could have resulted from systematic case management programs that ameliorated the adverse effects of low literacy. However, such programs were not instituted within this managed care plan until 1999, the very end of the follow-up period.

The number of years of school completed was not an important predictor of admissions. This should not be surprising. Someone who is 70 years old completed school approximately 50 years earlier. An individual's ability to deal with the current demands of being a patient is likely to be more dependent on what has happened in the 50 years following completion of school than on educational attainment at the time of graduation. Previous studies have shown that literacy is a more important predictor of health status and health care use than the number of years of school completed,[9,22] and this may be particularly true among the elderly. Studies that use years of school completed as a study variable may be unable to detect or may underestimate the relations between patients' ability to process health care information, health care use, and health outcomes.

This study had several limitations. Most important, only half of the eligible participants completed the study, and nonparticipants appeared to be of slightly higher socioeconomic status. However, hospitalization rates were comparable (29.5% for participants, 27.4% for those who refused to participate, and 27.8% for those whom we were unable to contact). This suggests that the study population was similar to the overall population and that our findings are likely to be representative of the broader group of plan enrollees. Nevertheless, the relation between literacy and hospital admission among study participants may have differed from that among nonparticipants.

We were unable to analyze differences in the reasons for hospital admission. Specifically, we had inadequate power to analyze differences in the risk of preventable hospitalizations or differences between medical admissions and elective surgical admissions. In addition, although we had extensive information on possible confounding variables, this information was based on self-report. If individuals with inadequate functional health literacy were less likely to be aware of chronic medical conditions such as hypertension and diabetes, our adjustments for these variables in multivariate modeling may have been incomplete. We also had a relatively short follow-up period, and the risks of hospital admission for those with inadequate

and adequate literacy appeared to be continuing to diverge at the end of the study period. Thus, this analysis could have underestimated the magnitude of the association between literacy and hospitalization. Finally, although we used health literacy as our main independent variable, we cannot state whether the relation between literacy and the risk of hospital admission would have been weaker or stronger if we had used a more general measure of reading comprehension.

Substantial evidence now indicates that inadequate functional health literacy adversely affects patients' knowledge, self-care for chronic diseases, health status, and risk of hospitalization.[23] However, to what degree the negative effects of inadequate literacy can be reduced remains unclear. Previous studies have shown that a patient education brochure for patients with low literacy can improve rates of immunization for pneumococcus,[24] and special graphics designed for individuals with low literacy may improve retention of presented information.[25] Nevertheless, inadequate literacy is more than just a reading problem. These individuals have global problems with both oral and written communication. Although rewriting health care information at a simpler level would greatly increase the number of people who could understand written health information,[26] many patients are unlikely to comprehend even the simplest written materials.

Additional efforts are needed to develop audiovisual aids and other tools to help communicate essential health care information to these patients, and large-scale intervention programs with careful evaluations are needed to determine whether these methods are successful. It may be useful to think of limited health literacy analogously to physical disabilities: we do not expect patients in wheelchairs to climb stairs to reach the hospital. Similarly, health care information should be made accessible to all individuals, regardless of reading ability. ■

About the Authors

David W. Baker is with the Center for Health Care Research and Policy and the Department of Medicine, Case Western Reserve University at MetroHealth Medical Center; and the Department of Epidemiology–Biostatistics, Case Western Reserve University School of Medicine, Cleveland, Ohio. Julie A. Gazmararian, Tracy Scott, Diane Green, Junling Ren, and Jennifer Peel are with US Quality Algorithms Center for Health Care Research, Atlanta, Ga. Mark V. Williams and Ruth M. Parker are with the Department of Medicine, Emory University School of Medicine, Atlanta, Ga.

Requests for reprints should be sent to David W. Baker, MD, MPH, Northwestern University Medical School, Suite 200, 676 North St. Clair Street, Chicago, Illinois 60611 (e-mail: dwbaker@northwestern.edu).

This article was accepted January 29, 2002.

Contributors

D.W. Baker (co–principal investigator) was responsible for conception of the project, study design, data collection, data analysis, interpretation of findings, and drafting of the manuscript. J.A. Gazmararian (co–principal investigator) assisted with study design, data collection, data analysis, interpretation of findings, and critical revision of the manuscript. M.V. Williams and R.M. Parker assisted with conception of the project, study design, data collection, and critical revision of the manuscript. T. Scott and D. Green assisted with study design, data collection, and critical revision of the manuscript. J. Ren assisted with study design and analyzed administrative records to track hospital admissions. J. Peel conducted statistical analyses and modeling of the risk of hospital admission.

Acknowledgments

This study was supported in part by a grant from the Robert Wood Johnson Foundation.

We also wish to thank Dr Jeffrey Koplan, former director of USQA Center for Health Care Research, for his support in the initial planning and design of the study; Joanne Nurss at the Georgia State Center for the Study of Adult Literacy for her advice throughout this project; and Charles Thomas for statistical support.

Human Participant Protection

The institutional review board at MetroHealth Medical Center and Emory University approved all aspects of this study.

References

1. Kirsch I, Jungeblut A, Jenkins L, Kolstad A. *Adult Literacy in America: A First Look at the Results of the National Adult Literacy Survey.* Washington, DC: National Center for Education, US Dept of Education; 1993.

2. Williams MV, Parker RM, Baker DW, et al. Inadequate functional health literacy among patients at two public hospitals. *JAMA.* 1995;274:1677–1682.

3. Williams MV, Baker DW, Honig EG, Lee ML, Nowlan A. Inadequate literacy is a barrier to asthma knowledge and self-care. *Chest.* 1998;114:1008–1015.

4. Williams MV, Baker DW, Parker RM, Nurss JR. Relationship of functional health literacy to patients' knowledge of their chronic disease: a study of patients with hypertension and diabetes. *Arch Intern Med.* 1998;158:166–172.

5. Baker DW, Gazmararian JA, Sudano J, Patterson M. The association between age and health literacy among elderly persons. *J Gerontol B Psychol Sci Soc Sci.* 2000;55:S368–S374.

6. Gazmararian JA, Baker DW, Williams MV, et al. Health literacy among Medicare enrollees in a managed care organization. *JAMA.* 1999;281:545–551.

7. Kuh D, Stirling S. Socioeconomic variation in admission for disease of female genital system and breast in a national cohort aged 15–43. *BMJ.* 1995;311:840–843.

8. Weiss BD, Blanchard JS, McGee DL, et al. Illiteracy among Medicaid recipients and its relationship to health care costs. *J Health Care Poor Underserved.* 1994;5:99–111.

9. Baker DW, Parker RM, Williams MV, Clark WS. Health literacy and the risk of hospital admission. *J Gen Intern Med.* 1998;13:791–798.

10. Baker DW, Williams MV, Parker RM, Gazmararian JA, Nurss J. Development of a brief test to measure functional health literacy. *Patient Educ Couns.* 1999;38:33–42.

11. Parker RM, Baker DW, Williams MV, Nurss JR. The Test of Functional Health Literacy in Adults (TOFHLA): a new instrument for measuring patients' literacy skills. *J Gen Intern Med.* 1995;10:537–542.

12. Mayfield D, McLeod G, Hall P. The CAGE questionnaire: validation of a new alcoholism screening instrument. *Am J Psychiatry.* 1974;131:1121–1123.

13. Sheikh JI, Yesavage JA. Geriatric Depression Scale (GDS): recent evidence and development of a shorter version. *Clin Gerontol.* 1986;5:165–172.

14. Ware JE Jr, Kosinski M, Keller SD. *SF-12: How to Score the SF-12 Physical and Mental Health Summary Scales.* Boston, Mass: The Health Institute; 1995.

15. Sherbourne CD, Stewart AL. The MOS Social Support Survey. *Soc Sci Med.* 1991;32:705–714.

16. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state": a practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res.* 1975;12:189–198.

17. Taylor W. Cloze procedure: a new tool for measuring readability. *Journalism Q.* 1953;30:415–433.

18. Davis TC, Long SW, Jackson RH, et al. Rapid estimate of adult literacy in medicine: a shortened screening instrument. *Fam Med.* 1993;25:391–395.

19. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis.* 1987;40:373–383.

20. Krauss NA, Machlin S, Kass BL. *Use of Health Care Services, 1996.* Rockville, Md: Agency for Health Care Policy and Research; 1999. MEPS Research Findings No. 7.

21. Baker DW, Parker RM, Williams MV, et al. The health care experience of patients with low literacy. *Arch Fam Med.* 1996;5:329–334.

22. Baker DW, Parker RM, Williams MV, Clark WS, Nurss J. The relationship of patient reading ability to self-reported health and use of health services. *Am J Public Health.* 1997;87:1027–1030.

23. Ad Hoc Committee on Health Literacy. Health literacy: report of the Council on Scientific Affairs. *JAMA.* 1999;281:552–557.

24. Jacobson TA, Thomas DM, Morton FJ, Offutt G, Shevlin J, Ray S. Use of a low-literacy patient education tool to enhance pneumococcal vaccination rates: a randomized controlled trial. *JAMA.* 1999;282:646–650.

25. Houts PS, Bachrach R, Witmer JT, Tringali CA, Bucher JA, Localio RA. Using pictographs to enhance recall of spoken medical instructions. *Patient Educ Couns.* 1998;35:83–88.

26. Doak CC, Doak LG, Root JH. *Teaching Patients With Low Literacy Skills.* Philadelphia, Pa: JB Lippincott; 1996.